

On the Structure of Sigillaria scutellata, Brongn., and other Eusigillarian Stems, in Comparison with those of other Palæozoic Lycopods.

By E. A. NEWELL ARBER, M.A., F.L.S., F.G.S., Trinity College, Cambridge University Demonstrator in Palæobotany, and HUGH H. THOMAS, B.A., formerly Scholar of Downing College, Cambridge.

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(Abstract.)

Petrified stems belonging to the genus *Sigillaria* have hitherto proved to be extremely rare in the Upper Carboniferous rocks. The present paper contains the first full account of the structure of the Eusigillariæ or ribbed Sigillarias of the Rhytidolepis section. Hitherto our knowledge of the anatomy of such stems has been limited to the account of the bark given by Williamson, and to brief descriptions of specimens, including the vascular cylinder, by Professor Bertrand and Dr. Scott.

The material, which forms the basis of the present study, consists of a petrification from the Lower Coal Measures of Shore-Littleborough in Lancashire, containing two well-preserved stems, lying side by side. The external surfaces of the ribs of both stems have been exposed by Mr. James Lomax, after much difficulty, and our thanks are due to him for his skill in preparing the sections. The characters of the ribs agree with those of the impressions known as *Sigillaria scutellata*, Brongn.

In addition, other stems are described in which the ribs are not exposed, and which cannot, therefore, be determined specifically. Radial and tangential sections through the bark of all these specimens show, however, that they belong to species of the Rhytidolepis section of the Eusigillariæ, which, like *Sigillaria scutellata*, possessed distant leaf scars. These additional petrifications agree exactly with *Sigillaria scutellata*, and have been made use of to illustrate further the anatomy of that species.

The stele has a well-marked pith, a tissue which is not, however, preserved in any of the stems which we have examined. The medullary cavity is bounded by a continuous ring of scalariform tracheides,—the primary wood,—the outer margin of which is crenulated. The protoxylem elements lie at the apices of the blunt, rounded teeth of the corona. The elements of the protoxylem and primary wood appear to consist entirely of scalariform tracheides. The elements of the secondary wood are also scalariform, and

rather smaller than those of the primary xylem, but, unlike them, they are arranged radially. The outer margin of this zone was crenulated, the ridges and grooves corresponding in position to those of the primary wood. The medullary rays usually consist of a single row of cells of varying height, of which the walls are sometimes thickened transversely.

The phloem and inner cortex of thin-walled elements are not preserved. A well developed band of phelloderm is found near the surface of the ribs. This is regarded as having arisen on the inner side of a meristematic zone. No definite cambial layer is to be found, and it is suggested that the meristematic activity here took place periodically. Cells are to be seen in this region which appear to have undergone division shortly before preservation took place, and rings of growth are to be observed in the older portions of the phelloderm. The secondary tissue consists of prismatic fibres, often chambered.

The ribs are really formed of cortical tissues, and not by fused leaf-bases. They consist largely of phelloderm, and externally what is probably a small zone of primary cortex, which lay without the region of secondary meristematic activity, still persists. The stems were probably ribbed long before the formation of the periderm. The leaf-bases, consisting of thin-walled parenchymatous elements, merely form bracket-like projections from the ribs; those of the same vertical series being sufficiently distant from each other to leave a small gap of primary cortex between them. The ribbing of the stem in the Eusigillariæ, being entirely independent of the form and arrangement of the leaf-bases, appears to be a natural feature of importance in classifying the Sigillariæ. No sign of branching has been observed in any specimen. The presence of a ligule and a ligular pit has been detected for the first time.

The course of the leaf-traces in the leaf-bases and cortical tissues has been followed with important results. The bundle is collateral, and without secondary wood. In the leaf-bases the trace consists of a *double xylem strand*, the two xylem groups being widely separated. These two strands unite as they pass through the phelloderm. The structure of the trace is almost identical with the foliar bundle of the leaf described by Scott as *Sigillariopsis sulcata*, which is obviously simply the leaf of a Eusigillarian stem.

The parichnos—the two strands of thin-walled elements, which accompany the leaf-trace through the leaf-base and cortex—increases greatly in size, as we pass from the exterior of the stem to the inner margin of the periderm. The two strands further unite, first below and then above the trace, so that, at a deep level in the periderm, the trace is completely surrounded by a broad zone of this tissue.

The leaf-traces pass through the secondary wood at first at an angle of about 60° to the vertical, but their course soon becomes almost horizontal, and this is maintained until near the inner margin of the wood, when they again bend sharply downwards, and eventually unite with the primary wood in one of the grooves of the corona.

The Eusigillariæ are compared anatomically with the Subsigillariæ, and it is found that there are four points in which they differ. In the Eusigillariæ, the stems are ribbed and the primary xylem always forms a continuous ring. The leaf-traces are monoxyle throughout their course. In the periderm, the xylem of the trace divides into two distinct strands, and these persist through the leaf-base, into the leaf, until near its apex, as the xylem of the foliar bundle. If, however, we regard *Sigillariopsis Decaisnei*, Ren., as a member of the Subsigillariæ, a conclusion which seems inevitable, then this latter characteristic is common to both groups, though in the Subsigillariæ it is combined with the diploxylic structure.

The Eusigillariæ are next compared with the various types of structure exhibited by *Lepidodendron* and *Lepidophloios*, with the conclusion that they correspond most closely to the Lepidodendroid trunks of Arran and Dalmeny. Anatomically they appear to be remote from *Bothrodendron*, so far as the structure of that genus is known. It is found that, in the absence of the cortical tissues, it is not possible to distinguish the stele of a Eusigillarian stem by any definite characters from that of some Lepidodendreæ. The genus *Diploxyton* is discussed in this connection, and it is shown that it is by no means certain that all the decorticated stems, which have been referred to it, belong to the Sigillariæ. It is more probable that the stems of several distinct genera are here grouped together, if only as a temporary expedient.
